* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The 1st source of a signal which is equipment made to generate a broadband FM modulating signal, and outputs the 1st electrical signal, It sets to the steady state from which an input electrical signal does not change, and is wavelength lambda 1. Light is oscillated. The laser for FM modulation which changes and outputs said 1st electrical signal which has the property to change amplitude change of an input electrical signal into a meaning at change of optical frequency, and is supplied as the input electrical signal concerned to a lightwave signal (it is hereafter called FM laser), The 2nd source of a signal which outputs the 2nd non-correlated electrical signal to said 1st electrical signal, The external light modulation section which carries out the optical phase modulation of the output lightwave signal from said FM laser with said 2nd electrical signal which has the property to change change of an input electrical signal into a meaning at change of an optical phase, and is supplied as the input electrical signal concerned, and is outputted, The 1st optical waveguide section which draws the output lightwave signal from said external light modulation section, and oscillation wavelength lambda 1 of said FM laser Wavelength lambda 0 from which only **lambda differs The source of station luminescence which outputs light, the 2nd optical waveguide section which draws the output light from said source of station luminescence, and square -- with a detection property When two light of different wavelength is inputted, it has the property to generate the beat component of the two light concerned in the frequency equivalent to the wavelength difference. The output lightwave signal from said external light modulation section drawn by said 1st optical waveguide section and the output light from said source of station luminescence drawn by said 2nd optical waveguide section are inputted. FM modulator equipped with the optical detection section which outputs the beat component of the two light concerned in the frequency equivalent to those wavelength difference **lambda.
[Claim 2] The 1st source of a signal which is equipment made to generate a broadband FM modulating signal, and outputs the 1st electrical signal, It sets to the steady state from which an input electrical signal does not change, and is wavelength lambda 1. Light is oscillated. The laser for FM modulation which changes and outputs said 1st electrical signal which has the property to change amplitude change of an input electrical signal into a meaning at change of optical frequency, and is supplied as the input electrical signal concerned to a lightwave signal (it is hereafter called FM laser), The 1st optical waveguide section which draws the output lightwave signal from said FM laser, and the 2nd source of a signal which outputs the 2nd non-correlated electrical signal to said 1st electrical signal, Oscillation wavelength lambda 1 of said FM laser Wavelength lambda 0 from which only **lambda differs The source of station luminescence which outputs light, The external light modulation section which carries out the optical phase modulation of the output light from said source of station luminescence with said 2nd electrical signal which has the property to change change of an input electrical signal into a meaning at change of an optical phase, and is supplied as the input electrical signal concerned, and is outputted, the 2nd optical waveguide section which draws the output lightwave signal from said external light modulation section, and square -- with a detection property When two light of different wavelength is inputted, it has the property to generate the beat component of the two light concerned in the frequency equivalent to the wavelength difference. The output lightwave signal from said FM laser led by said 1st optical waveguide section and the output lightwave signal from said extraneous light phase modulation section drawn by said 2nd optical waveguide section are inputted. FM modulator equipped with the optical detection section which outputs the beat component of the two light concerned in the frequency equivalent to those wavelength difference **lambda.
[Claim 3] The 1st source of a signal which is equipment made to generate a broadband FM modulating signal, and outputs the 1st electrical signal, It sets to the steady state from which an input electrical signal does not

change, and is wavelength lambda 1. Light is oscillated. The laser for FM modulation which changes and outputs said 1st electrical signal which has the property to change amplitude change of an input electrical signal into a meaning at change of optical frequency, and is supplied as the input electrical signal concerned to a lightwave signal (it is hereafter called FM laser), The 1st optical waveguide section which draws the output lightwave signal from said FM laser, and the 2nd source of a signal which outputs the 2nd non-correlated electrical signal to said 1st electrical signal, It sets to the steady state from which an input electrical signal does not change, and is the oscillation wavelength lambda 1 of said FM laser. Wavelength lambda 0 from which only deltalambda differs Light is oscillated. The source of station luminescence which changes and outputs said 2nd electrical signal which has the property to change amplitude change of an input electrical signal into a meaning at change of optical frequency, and is supplied as the input electrical signal concerned to a lightwave signal, the 2nd optical waveguide section which draws the output lightwave signal from said source of station luminescence, and square -- with a detection property When two light of different wavelength is inputted, it has the property to generate the beat component of the two light concerned in the frequency equivalent to the wavelength difference. The output lightwave signal from said FM laser led by said 1st optical waveguide section and the output lightwave signal from said source of station luminescence drawn by said 2nd optical waveguide section are inputted. FM modulator equipped with the optical detection section which outputs the beat component of the two light concerned in the frequency equivalent to those wavelength difference **lambda.

[Claim 4] The 1st source of a signal which is equipment made to generate a broadband FM modulating signal, and outputs the 1st electrical signal, The 2nd source of a signal which outputs the 2nd non-correlated electrical signal to said 1st electrical signal, The multiplexing section which multiplexs and outputs said the 1st electrical signal and said 2nd electrical signal, It sets to the steady state from which an input electrical signal does not change, and is wavelength lambda 1. Light is oscillated. The laser for FM modulation which changes and outputs the electrical signal which has the property to change amplitude change of an input electrical signal into a meaning at change of optical frequency, and is outputted from said multiplexing section to a lightwave signal (henceforth FM laser), The 1st optical waveguide section which draws the output lightwave signal from said FM laser, and oscillation wavelength lambda 1 of said FM laser Wavelength lambda 0 from which only **lambda differs The source of station luminescence which outputs light, the 2nd optical waveguide section which draws the output light from said source of station luminescence, and square -- with a detection property When two light of different wavelength is inputted, it has the property to generate the beat component of the two light concerned in the frequency equivalent to the wavelength difference. The output lightwave signal from said FM laser led by said 1st optical waveguide section and the output light from said source of station luminescence drawn by said 2nd optical waveguide section are inputted. FM modulator equipped with the optical detection section which outputs the beat component of the two light concerned in the frequency equivalent to those wavelength difference **lambda.

[Claim 5] FM modulator according to claim 1 to 4 with which the frequency of said 2nd electrical signal is characterized by the high thing compared with the frequency of said 1st electrical signal.

[Claim 6] FM modulator according to claim 1 to 4 with which the frequency of said 2nd electrical signal is characterized by being larger than the twice of the frequency of said 1st electrical signal.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] More specifically, this invention relates to FM modulator which generates FM modulating signal about FM modulator using semiconductor laser.
[0002]
[Description of the Prior Art] Drawing 5 is the block diagram having shown the configuration of the conventional FM modulator. FM modulator is equipped with the source 501 of a signal, the laser 502 for FM modulation (henceforth FM laser), the 1st optical waveguide section 503, the source 504 of office luminescence, the 2nd optical waveguide section 505, and the optical detection section 506 in drawing 5 .
[0003] In FM modulator constituted as mentioned above, the source 501 of a signal outputs the electrical signal used as the dimension signal which should carry out FM modulation. It consists of semiconductor laser and the FM laser 502 is wavelength lambda 1 at the conditions of inrush current regularity. When light is oscillated and amplitude modulation of the inrush current is carried out, the oscillation wavelength (optical frequency) also receives a modulation, and it is wavelength lambda 1. The optical frequency modulating signal made into the core is outputted. The 1st optical waveguide section 503 draws the lightwave signal outputted from this FM laser 502. The source 504 of station luminescence is the oscillation wavelength lambda 1 of the FM laser 502, and the wavelength lambda 0 from which only specified quantity **lambda differs. Light is outputted. The 2nd optical waveguide section 505 draws a light from the source 504 of station luminescence non-become irregular. It is multiplexed and two light drawn by the 1st optical waveguide section 503 and the 2nd optical waveguide section 505 is inputted into the optical detection section 506. the optical detection section 506 -- square -- it consisting of photodiodes which have a detection property, and, when two light of different wavelength is inputted The frequency equivalent to that wavelength difference is equipped with the property to generate the beat component of two light (this actuation is called heterodyne detection). The beat signal of these two light is outputted in the frequency equivalent to wavelength difference **lambda of the output lightwave signal from the FM laser 502 led by the 1st optical waveguide section 503, and the output light from the source 504 of station luminescence drawn by the 2nd optical waveguide section 505.
[0004] The beat signal acquired as mentioned above is an FM modulating signal which made the dimension signal the output signal from the source 501 of a signal, and can generate a RF and broadband FM modulating signal easily with FM modulator by the general electrical circuit in an emergency with the center frequency (carrier frequency) of several GHz or more and the amount of frequency deviation of several 100MHz or more with difficult implementation by using the suitable thing for the FM laser 502 and the source 504 of station luminescence. FM recovery signal which restores to this FM modulating signal and is acquired by amplification of this amount of frequency deviation will have high [CNR (subcarrier pair noise power ratio)].
[0005] An example of the whole configuration of the transmission equipment which included FM modulator shown in drawing 5 in drawing 6 is shown. Reference (for example) KKikushima, et al., and" Optical super wide-band FM modulation scheme So that it may be indicated by and its application to multi-channel AM video transmission systems", IOOC'95 and PD 2-7, and 1995. this transmission equipment After the optical transmitting section 602 changes into a modulating signal on the strength [optical] the broadband FM modulating signal generated in an FM modulator 601 like drawing 5 with the laser 603 for transmission included inside, the modulating signal concerned on the strength [optical] is transmitted using an optical transmission line 604. After transmission equipment reconverts the modulating signal on the strength [optical] received by the optical receive section 605 to FM modulating signal, it restores to it to the original electrical signal by the FM demodulator circuit 607.

The FM demodulator circuit 607 is the predetermined threshold Vref to FM modulating signal into which it is the FM demodulator of a delay detection system, and the discernment section 608 was inputted from the optical receive section 605. It identifies and changes into a pulse signal (logic signal). Moreover, this discernment section 608 has two output ports, and the output signal of direct and another side is inputted into the multiplication section 610 after one output signal is able to give the predetermined amount of delay in the delay section 609. The multiplication section 610 creates the AND signal (pulse signal) of both pulse signals. If a filter 611 passes only a low-frequency component to this pulse signal and outputs, the amplitude fluctuation component of that output signal will be equivalent to the frequency-drift component of an input FM modulating signal at a meaning, and will restore to FM modulating signal by this. In the discernment section 608 and the multiplication section 610, it can restore to the RF and broadband FM modulating signal which were generated with the configuration of drawing 5 easily by using the logical elements for high speed signal processing (AND gate etc.).
[0006] By the way, it is known that will set to the transmission equipment of FM modulating signal, and the group delay frequency characteristics of the transmission line in the band of FM modulating signal will generally affect the quality of a transmission signal. for example, as shown in drawing 7 (a), about the case where the frequency characteristics of the amount of group delays change comparatively gently into a band In the secondary distorted components [3rd] of a low degree occurring and changing the amount of group delays like drawing 7 (b) in the shape of [which has fine crest and trough in band] a ripple The 4th high order more than distortion occurs as stated also to reference (for example, others [Ishii]; ″theoretical examination about the group-delay distortion in a broadband FM modulation type light image transmission system″, Shingaku Giho OCS 96-17, 1996., etc.), and transmission-signal quality is degraded. Application of the distorted reduction technique by a distorted compensation technique etc. is difficult, and it is necessary to fully oppress the ripple in a band of a group delay beforehand especially about the high order distortion of the latter. However, it is generated in the mismatching of the impedance between the component parts used for a transmission line, or in a component part in most cases, and it is dramatically difficult for group delay frequency characteristics to make it there be nothing.
[0007] Next, the difference (delta output voltage) between the approximate value at the time of carrying out straight-line approximation of the f-V property for the example of 1 measurement of the input frequency pair output-signal level (f-V property) of the FM demodulator circuit 607 explained by drawing 6 at drawing 8 (a) and a true value is shown in drawing 8 (b). It has the fine ripple, and it becomes the factor which this also makes generate high order distortion, and the quality of a transmission signal is degraded so that drawing 8 (b) may show, although it is desirable also about the f-V property of the viewpoint of the waveform distortion of a recovery signal to FM demodulator circuit that it is linearity.
[0008] As mentioned above, in the transmission equipment of FM modulating signal, the nonlinearity in group delay frequency characteristics and FM recovery property of a transmission line affects the quality of a transmission signal. In order that the band of a transmission signal may extend for several GHz, the number of the crest and troughs of the ripple in the band in group delay frequency characteristics or FM recovery property also increases dramatically, a higher order distortion occurs, and the quality of a transmission signal is made to deteriorate greatly in the transmission equipment of a broadband FM modulating signal especially explained using drawing 5 - drawing 8 .
[0009]
[Problem(s) to be Solved by the Invention] As mentioned above, when the broadband FM modulating signal generated with FM modulator using optical frequency modulation actuation and heterodyne detection of semiconductor laser is transmitted, While CNR is improvable with the amount of large frequency deviation, in order that FM modulating signal may cover a broadband dramatically Since the group delay frequency characteristics of a transmission line and the recovery property of an FM demodulator in the band were changed in the shape of [which has very many crests and troughs] a ripple, a higher order distortion occurred greatly and there was a trouble of degrading the quality of a transmission signal.
[0010] So, the object of this invention is offering FM modulator with which the broadband FM modulating signal generated using optical frequency modulation actuation and heterodyne detection of semiconductor laser graduates substantially the ripple of the group delay frequency characteristics of a transmission line and FM recovery property of being influenced, and can reduce high order distortion.
[0011]
[The means for solving a technical problem and an effect of the invention] The 1st source of a signal which the

1st invention is equipment made to generate a broadband FM modulating signal, and outputs the 1st electrical signal, It sets to the steady state from which an input electrical signal does not change, and is wavelength lambda 1. Light is oscillated. The laser for FM modulation which changes and outputs the 1st electrical signal which has the property to change amplitude change of an input electrical signal into a meaning at change of optical frequency, and is supplied as the input electrical signal concerned to a lightwave signal (it is hereafter called FM laser), The 2nd source of a signal which outputs the 2nd non-correlated electrical signal to the 1st electrical signal, The external light modulation section which carries out the optical phase modulation of the output lightwave signal from FM laser with the 2nd electrical signal which has the property to change change of an input electrical signal into a meaning at change of an optical phase, and is supplied as the input electrical signal concerned, and is outputted, the 1st optical waveguide section which draws the output lightwave signal from the external light modulation section, and oscillation wavelength lambda 1 of FM laser Wavelength lambda 0 from which only **lambda differs the source of station luminescence which outputs light, the 2nd optical waveguide section which draws the output light from the source of station luminescence, and square -- with a detection property When two light of different wavelength is inputted, it has the property to generate the beat component of the two light concerned in the frequency equivalent to the wavelength difference. The output lightwave signal from the external light modulation section drawn by the 1st optical waveguide section and the output light from the source of station luminescence drawn by the 2nd optical waveguide section are inputted, and it has the optical detection section which outputs the beat component of the two light concerned in the frequency equivalent to those wavelength difference **lambda.
[0012] By modulating the inrush current of FM laser, an optical frequency modulating signal is generated and the broadband FM modulating signal generated by carrying out heterodyne detection of this generates high order distortion at the time of a recovery by the ripple of the group delay frequency characteristics of a transmission line, or FM recovery property. In the 1st above-mentioned invention, further the optical frequency modulating signal outputted from FM laser using the external light modulation section then, by performing the optical phase modulation [**** / modulating signal / optical frequency / from FM laser /-less] FM modulator which graduates the ripple of group delay frequency characteristics or FM recovery property on parenchyma, oppresses high order distortion which should be generated by these, and oppresses wave degradation by the property of a transmission line or FM demodulator circuit is realizable.
[0013] The 1st source of a signal which the 2nd invention is equipment made to generate a broadband FM modulating signal, and outputs the 1st electrical signal, It sets to the steady state from which an input electrical signal does not change, and is wavelength lambda 1. Light is oscillated. The laser for FM modulation which changes and outputs the 1st electrical signal which has the property to change amplitude change of an input electrical signal into a meaning at change of optical frequency, and is supplied as the input electrical signal concerned to a lightwave signal (it is hereafter called FM laser), The 1st optical waveguide section which draws the output lightwave signal from FM laser, and the 2nd source of a signal which outputs the 2nd non-correlated electrical signal to the 1st electrical signal, Oscillation wavelength lambda 1 of FM laser Wavelength lambda 0 from which only **lambda differs The source of station luminescence which outputs light, The external light modulation section which carries out the optical phase modulation of the output light from the source of station luminescence with the 2nd electrical signal which has the property to change change of an input electrical signal into a meaning at change of an optical phase, and is supplied as the input electrical signal concerned, and is outputted, the 2nd optical waveguide section which draws the output lightwave signal from the external light modulation section, and square -- with a detection property When two light of different wavelength is inputted, it has the property to generate the beat component of the two light concerned in the frequency equivalent to the wavelength difference. The output lightwave signal from FM laser led by the 1st optical waveguide section and the output lightwave signal from the extraneous light phase modulation section drawn by the 2nd optical waveguide section are inputted, and it has the optical detection section which outputs the beat component of the two light concerned in the frequency equivalent to those wavelength difference **lambda.
[0014] In the 2nd above-mentioned invention, FM modulator which graduates the ripple of group delay frequency characteristics or FM recovery property on parenchyma, oppresses high order distortion which should be generated by these like the 1st invention, and oppresses wave degradation by the property of a transmission line or FM demodulator circuit is realizable by multiplexing the output lightwave signal from the extraneous light phase modulation section [**** / modulating signal / optical frequency / from FM laser /-less].
[0015] The 1st source of a signal which the 3rd invention is equipment made to generate a broadband FM modulating signal, and outputs the 1st electrical signal, It sets to the steady state from which an input electrical

signal does not change, and is wavelength lambda 1. Light is oscillated. The laser for FM modulation which changes and outputs the 1st electrical signal which has the property to change amplitude change of an input electrical signal into a meaning at change of optical frequency, and is supplied as the input electrical signal concerned to a lightwave signal (it is hereafter called FM laser), The 1st optical waveguide section which draws the output lightwave signal from FM laser, and the 2nd source of a signal which outputs the 2nd non-correlated electrical signal to the 1st electrical signal, It sets to the steady state from which an input electrical signal does not change, and is the oscillation wavelength lambda 1 of FM laser. Wavelength lambda 0 from which only deltalambda differs Light is oscillated. The source of station luminescence which changes and outputs the 2nd electrical signal which has the property to change amplitude change of an input electrical signal into a meaning at change of optical frequency, and is supplied as the input electrical signal concerned to a lightwave signal, the 2nd optical waveguide section which draws the output lightwave signal from the source of station luminescence, and square -- with a detection property When two light of different wavelength is inputted, it has the property to generate the beat component of the two light concerned in the frequency equivalent to the wavelength difference. The output lightwave signal from FM laser led by the 1st optical waveguide section and the output lightwave signal from the source of station luminescence drawn by the 2nd optical waveguide section are inputted, and it has the optical detection section which outputs the beat component of the two light concerned in the frequency equivalent to those wavelength difference **lambda.

[0016] In the 3rd above-mentioned invention, FM modulator which graduates the ripple of group delay frequency characteristics or FM recovery property on parenchyma, oppresses high order distortion which should be generated by these like the 1st invention, and oppresses wave degradation by the property of a transmission line or FM demodulator circuit is realizable by multiplexing the output lightwave signal from the source [**** / modulating signal / optical frequency / from FM laser /-less] of office luminescence.

[0017] The 1st source of a signal which the 4th invention is equipment made to generate a broadband FM modulating signal, and outputs the 1st electrical signal, The 2nd source of a signal which outputs the 2nd non-correlated electrical signal to the 1st electrical signal, It sets to the multiplexing section which multiplexs and outputs the 1st electrical signal and 2nd electrical signal, and the steady state from which an input electrical signal does not change, and is wavelength lambda 1. Light is oscillated. The laser for FM modulation which changes and outputs the electrical signal which has the property to change amplitude change of an input electrical signal into a meaning at change of optical frequency, and is outputted from the multiplexing section to a lightwave signal (henceforth FM laser), the 1st optical waveguide section which draws the output lightwave signal from FM laser, and oscillation wavelength lambda 1 of FM laser Wavelength lambda 0 from which only **lambda differs the source of station luminescence which outputs light, the 2nd optical waveguide section which draws the output light from the source of station luminescence, and square -- with a detection property When two light of different wavelength is inputted, it has the property to generate the beat component of the two light concerned in the frequency equivalent to the wavelength difference. The output lightwave signal from FM laser led by the 1st optical waveguide section and the output light from the source of station luminescence drawn by the 2nd optical waveguide section are inputted, and it has the optical detection section which outputs the beat component of the two light concerned in the frequency equivalent to those wavelength difference **lambda.

[0018] By multiplexing the 2nd electrical signal [**** / electrical signal / 1st /-less] in the 4th above-mentioned invention, and performing an optical frequency modulation using optical frequency modulation actuation of FM laser in addition to FM laser FM modulator which graduates the ripple of group delay frequency characteristics or FM recovery property on parenchyma, oppresses high order distortion which should be generated by these like the 1st invention, and oppresses wave degradation by the property of a transmission line or FM demodulator circuit is realizable.

[0019] 5th invention is characterized by the frequency of the 2nd electrical signal being high compared with the frequency of the 1st electrical signal in the 1st - one of invention of the 4th. In the 5th above-mentioned invention, it is set as a RF rather than the 1st electrical signal which should transmit the 2nd electrical signal essentially, and the substantial smoothing effectiveness of the ripple of the group delay frequency characteristics in the 1st - the 4th invention and FM recovery property is clarified more.

[0020] 6th invention is characterized by the frequency of the 2nd electrical signal being larger than the twice of the frequency of the 1st electrical signal in the 1st - one of invention of the 4th. In the 6th above-mentioned invention, the 1st electrical signal which should transmit the frequency of the 2nd electrical signal essentially is larger than twice, and it sets up, and avoids that the distorted component generated by the interaction of the

1st electrical signal and the 2nd electrical signal serves as an interference to the 1st electrical signal, and the substantial smoothing effectiveness of the ripple of the group delay frequency characteristics in the 1st - the 4th invention and FM recovery property is clarified more.
[0021]
[Embodiment of the Invention] FM modulator concerning the 1st operation gestalt of this invention is explained with reference to drawing 1 which shows the component and a connection mode. In drawing 1 , FM modulator is equipped with the 1st source 101 of a signal, the laser 102 for FM modulation (henceforth, FM laser), the 1st optical waveguide section 103, the source 104 of office luminescence, the 2nd optical waveguide section 105, the optical detection section 106, the 2nd source 107 of a signal, and the extraneous light phase modulation section 108 as the component.
[0022] Next, the connection mode of FM modulator and actuation which are shown in drawing 1 are explained. The 1st source 101 of a signal outputs the 1st electrical signal used as the dimension signal which should carry out FM modulation. Typically, it consists of semiconductor laser, it sets under the condition of inrush current regularity, and the FM laser 102 is wavelength lambda 1. When light is oscillated and amplitude modulation of the inrush current is carried out with the 1st electrical signal, oscillation wavelength (optical frequency) also receives a modulation and it is wavelength lambda 1. The optical frequency modulating signal made into the core is outputted. The 2nd source 107 of a signal outputs the 2nd electrical signal [**** / electrical signal / 1st /-less], and the extraneous light phase modulation section 108 performs an optical phase modulation with the 2nd electrical signal to the output lightwave signal from the FM laser 102. The 1st optical waveguide section 103 draws the lightwave signal outputted from this external light modulation section 108. The source 104 of station luminescence is the oscillation wavelength lambda 1 of the FM laser 102. Wavelength lambda 0 from which only specified quantity **lambda differs Light is outputted. The 2nd optical waveguide section 105 draws a light from the source 104 of station luminescence non-become irregular. It is multiplexed and two light drawn by the 1st optical waveguide section 103 and the 2nd optical waveguide section 105 is inputted into the optical detection section 106. the optical detection section 106 -- the square -- a detection property performs heterodyne detection and the beat signal of the two light concerned is outputted in the frequency equivalent to wavelength difference **lambda of the output lightwave signal from the extraneous light phase modulation section 108, and the output light from the source 104 of station luminescence. This beat signal is a broadband FM modulating signal which made the dimension signal the 1st electrical signal and 2nd electrical signal.
[0023] Drawing 2 is the block diagram showing the configuration of FM modulator concerning the 2nd operation gestalt of this invention. In drawing 2 , since FM modulator has the same component as the 1st operation gestalt, it attaches the same reference number about a corresponding component. However, since a connection mode is different with the 1st and 2nd operation gestalten, below actuation of FM modulator applied to the 2nd operation gestalt focusing on this point of difference is explained, and explanation of a point clear from the 1st operation gestalt is omitted. The 1st optical waveguide section 103 leads the lightwave signal outputted from the FM laser 102 to the optical detection section 106. The extraneous light phase modulation section 108 performs an optical phase modulation with the 2nd electrical signal to a light from the source 104 of station luminescence non-become irregular. The 2nd optical waveguide section 105 leads the lightwave signal outputted from this extraneous light phase modulation section 108 to the optical detection section 106. The optical detection section 106 outputs the beat signal of the two light concerned in the frequency equivalent to wavelength difference **lambda of the output lightwave signal from the FM laser 102, and the output lightwave signal from the extraneous light phase modulation section 108.
[0024] Drawing 3 is the block diagram showing the configuration of FM modulator concerning the 3rd operation gestalt of this invention. In drawing 3 , since only the points which are not equipped with the extraneous light phase modulation section 108 as compared with the 2nd operation gestalt differ, FM modulator gives the same reference number to a corresponding configuration. Furthermore, since a connection mode is also different with the 2nd and 3rd operation gestalten, below actuation of FM modulator applied to the 3rd operation gestalt focusing on these points of difference is explained, and explanation of a point clear from the 2nd operation gestalt is omitted. Typically, it consists of semiconductor laser, it sets under the condition of inrush current regularity, and the source 104 of station luminescence is wavelength lambda 0. When light is oscillated and amplitude modulation of the inrush current is carried out with the 2nd electrical signal, oscillation wavelength (optical frequency) also receives a modulation and it is wavelength lambda 0. The optical frequency modulating signal made into the core is outputted. The 2nd optical waveguide section 105 draws the lightwave signal outputted from this source 104 of station luminescence. The optical detection section 106 outputs the beat

signal of the two light concerned in the frequency equivalent to wavelength difference **lambda of the output lightwave signal from the FM laser 102, and the output light from the source 104 of station luminescence.
[0025] above-mentioned the 1- the 2nd electrical signal graduates the periodic fine ripple in group delay frequency characteristics and FM recovery property in a transmission line of FM modulating signal on parenchyma, and oppresses the waveform distortion at the time of the recovery of the broadband FM modulating signal by this in the 3rd operation gestalt, not affecting transmission of the 1st electrical signal, and the signal quality at the time of a recovery to the 1st electrical signal which should be transmitted essentially, since it is a signal [**** /-less]. Moreover, especially, since it has composition which supplies the 2nd electrical signal to the source 104 of station luminescence directly in the 3rd operation gestalt and the extraneous light phase modulation section 108 which was required of the 1st and 2nd operation gestalten is not needed, FM modulator can be constituted easily and the manufacturing cost can be reduced.
[0026] Drawing 4 is the block diagram showing the configuration of FM modulator concerning the 4th operation gestalt of this invention. In drawing 4 , since only the points which replace with the extraneous light phase modulation section 108 as compared with the 1st operation gestalt, and are equipped with the multiplexing section 109 differ, FM modulator gives the same reference number to a corresponding configuration. Furthermore, since a connection mode is also different with the 1st and 4th operation gestalten, below actuation of FM modulator applied to the 4th operation gestalt focusing on these points of difference is explained, and explanation of a point clear from the 1st operation gestalt is omitted. The multiplexing section 109 multiplexs the 1st electrical signal and 2nd electrical signal mutually, and inputs this into the FM laser 102. [**** /-less] The FM laser 102 carries out amplitude modulation of the inrush current with the electrical signal outputted from this multiplexing section 109, and is wavelength lambda 1. The optical frequency modulating signal made into the core is outputted. The 1st optical waveguide section 103 leads the lightwave signal outputted from the FM laser 102 to the optical detection section 106. The optical detection section 106 outputs the beat signal of the two light concerned in the frequency equivalent to wavelength difference **lambda of the output lightwave signal from the FM laser 102, and the output light from the source 104 of station luminescence.
[0027] here -- above-mentioned the 1- like the 3rd operation gestalt, to the 1st electrical signal which should be transmitted essentially, since the 2nd electrical signal is a signal [**** /-less], without affecting transmission of the 1st electrical signal, and the signal quality at the time of a recovery, it graduates the periodic fine ripple in the group delay frequency characteristics of a transmission line, or the f-V property of FM demodulator circuit on parenchyma, and oppresses the waveform distortion at the time of the recovery of the broadband FM modulating signal by this. However, with the 4th operation gestalt both, since the 1st electrical signal and 2nd electrical signal are mutually inputted into the FM laser 102, it is necessary to set up the input level to the FM laser 102 of both signals so that total of whenever [light modulation] may not exceed 100%. [**** /-less]
[0028] FM modulator concerning the 5th operation gestalt of this invention is explained. the component of this FM modulator -- the 1- since it is the same as that of either of the 4th operation gestalt, explanation of the connection mode and actuation is omitted. In this operation gestalt, it supposes no correlating the 2nd electrical signal with the 1st electrical signal, and it sets the frequency as a RF compared with the 1st electrical signal further. the substantial smooth effectiveness by the 2nd electrical signal over a periodic fine ripple [in / by this / the group delay frequency characteristics of a transmission line, or the recovery property of FM demodulator circuit] -- the 1- it improves rather than that of the 4th operation gestalt. Moreover, this smooth effectiveness improves, so that the frequency of the 2nd electrical signal is high.
[0029] FM modulator concerning the 6th operation gestalt of this invention is explained. the component of this FM modulator -- the 1- since it is the same as that of either of the 4th operation gestalt, explanation of the connection mode and actuation is omitted. In this operation gestalt, it supposes no correlating the 2nd electrical signal with the 1st electrical signal, and it sets up the frequency compared with the 1st electrical signal more greatly than twice further. the substantial smooth effectiveness by the 2nd electrical signal over a periodic fine ripple [in / it prevents the secondary intermodulation distortion between the 1st and 2nd electrical signals occurring in the occupancy band of the 1st electrical signal by this when the occupancy band of the 1st electrical signal is large, and / the group delay frequency characteristics of a transmission line, or the recovery property of FM demodulator circuit] -- the 1- it improves rather than that of the 4th operation gestalt. Moreover, this smooth effectiveness improves, so that the frequency of the 2nd electrical signal is high.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] More specifically, this invention relates to FM modulator which generates FM modulating signal about FM modulator using semiconductor laser.

[Translation done.]

PRIOR ART

[Description of the Prior Art] Drawing 5 is the block diagram having shown the configuration of the conventional FM modulator. FM modulator is equipped with the source 501 of a signal, the laser 502 for FM modulation (henceforth FM laser), the 1st optical waveguide section 503, the source 504 of office luminescence, the 2nd optical waveguide section 505, and the optical detection section 506 in drawing 5 .
[0003] In FM modulator constituted as mentioned above, the source 501 of a signal outputs the electrical signal used as the dimension signal which should carry out FM modulation. It consists of semiconductor laser and the FM laser 502 is wavelength lambda 1 at the conditions of inrush current regularity. When light is oscillated and amplitude modulation of the inrush current is carried out, the oscillation wavelength (optical frequency) also receives a modulation, and it is wavelength lambda 1. The optical frequency modulating signal made into the core is outputted. The 1st optical waveguide section 503 draws the lightwave signal outputted from this FM laser 502. The source 504 of station luminescence is the oscillation wavelength lambda 1 of the FM laser 502, and the wavelength lambda 0 from which only specified quantity **lambda differs. Light is outputted. The 2nd optical waveguide section 505 draws a light from the source 504 of station luminescence non-become irregular. It is multiplexed and two light drawn by the 1st optical waveguide section 503 and the 2nd optical waveguide section 505 is inputted into the optical detection section 506. the optical detection section 506 -- square -- it consisting of photodiodes which have a detection property, and, when two light of different wavelength is inputted The frequency equivalent to that wavelength difference is equipped with the property to generate the beat component of two light (this actuation is called heterodyne detection). The beat signal of these two light is outputted in the frequency equivalent to wavelength difference **lambda of the output lightwave signal from the FM laser 502 led by the 1st optical waveguide section 503, and the output light from the source 504 of station luminescence drawn by the 2nd optical waveguide section 505.
[0004] The beat signal acquired as mentioned above is an FM modulating signal which made the dimension signal the output signal from the source 501 of a signal, and can generate a RF and broadband FM modulating signal easily with FM modulator by the general electrical circuit in an emergency with the center frequency (carrier frequency) of several GHz or more and the amount of frequency deviation of several 100MHz or more with difficult implementation by using the suitable thing for the FM laser 502 and the source 504 of station luminescence. FM recovery signal which restores to this FM modulating signal and is acquired by amplification of this amount of frequency deviation will have high [CNR (subcarrier pair noise power ratio)].
[0005] An example of the whole configuration of the transmission equipment which included FM modulator shown in drawing 5 in drawing 6 is shown. Reference (for example) KKikushima, et al., and" Optical super wide-band FM modulation scheme So that it may be indicated by and its application to multi-channel AM video transmission systems", IOOC'95 and PD 2-7, and 1995. this transmission equipment After the optical transmitting section 602 changes into a modulating signal on the strength [optical] the broadband FM modulating signal generated in an FM modulator 601 like drawing 5 with the laser 603 for transmission included inside, the modulating signal concerned on the strength [optical] is transmitted using an optical transmission line 604. After transmission equipment reconverts the modulating signal on the strength [optical] received by the optical receive section 605 to FM modulating signal, it restores to it to the original electrical signal by the FM demodulator circuit 607. The FM demodulator circuit 607 is the predetermined threshold Vref to FM modulating signal into which it is the FM demodulator of a delay detection system, and the discernment section 608 was inputted from the optical receive section 605. It identifies and changes into a pulse signal (logic signal). Moreover, this discernment section 608 has two output ports, and the output signal of direct and another side is inputted into the multiplication section 610 after one output signal is able to give the predetermined amount of delay in the delay

section 609. The multiplication section 610 creates the AND signal (pulse signal) of both pulse signals. If a filter 611 passes only a low-frequency component to this pulse signal and outputs, the amplitude fluctuation component of that output signal will be equivalent to the frequency-drift component of an input FM modulating signal at a meaning, and will restore to FM modulating signal by this. In the discernment section 608 and the multiplication section 610, it can restore to the RF and broadband FM modulating signal which were generated with the configuration of drawing 5 easily by using the logical elements for high speed signal processing (AND gate etc.).

[0006] By the way, it is known that will set to the transmission equipment of FM modulating signal, and the group delay frequency characteristics of the transmission line in the band of FM modulating signal will generally affect the quality of a transmission signal. for example, as shown in drawing 7 (a), about the case where the frequency characteristics of the amount of group delays change comparatively gently into a band In the secondary distorted components [3rd] of a low degree occurring and changing the amount of group delays like drawing 7 (b) in the shape of [which has fine crest and trough in band] a ripple The 4th high order more than distortion occurs as stated also to reference (for example, others [Ishii]; "theoretical examination about the group-delay distortion in a broadband FM modulation type light image transmission system", Shingaku Giho OCS 96-17, 1996., etc.), and transmission-signal quality is degraded. Application of the distorted reduction technique by a distorted compensation technique etc. is difficult, and it is necessary to fully oppress the ripple in a band of a group delay beforehand especially about the high order distortion of the latter. However, it is generated in the mismatching of the impedance between the component parts used for a transmission line, or in a component part in most cases, and it is dramatically difficult for group delay frequency characteristics to make it there be nothing.

[0007] Next, the difference (delta output voltage) between the approximate value at the time of carrying out straight-line approximation of the f-V property for the example of 1 measurement of the input frequency pair output-signal level (f-V property) of the FM demodulator circuit 607 explained by drawing 6 at drawing 8 (a) and a true value is shown in drawing 8 (b). It has the fine ripple, and it becomes the factor which this also makes generate high order distortion, and the quality of a transmission signal is degraded so that drawing 8 (b) may show, although it is desirable also about the f-V property of the viewpoint of the waveform distortion of a recovery signal to FM demodulator circuit that it is linearity.

[0008] As mentioned above, in the transmission equipment of FM modulating signal, the nonlinearity in group delay frequency characteristics and FM recovery property of a transmission line affects the quality of a transmission signal. In order that the band of a transmission signal may extend for several GHz, the number of the crest and troughs of the ripple in the band in group delay frequency characteristics or FM recovery property also increases dramatically, a higher order distortion occurs, and the quality of a transmission signal is made to deteriorate greatly in the transmission equipment of a broadband FM modulating signal especially explained using drawing 5 - drawing 8 .

[Translation done.]

* NOTICES *

JPO and NCIPI are not responsible for any
damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

EFFECT OF THE INVENTION

[The means for solving a technical problem and an effect of the invention] The 1st source of a signal which the 1st invention is equipment made to generate a broadband FM modulating signal, and outputs the 1st electrical signal, It sets to the steady state from which an input electrical signal does not change, and is wavelength lambda 1. Light is oscillated. The laser for FM modulation which changes and outputs the 1st electrical signal which has the property to change amplitude change of an input electrical signal into a meaning at change of optical frequency, and is supplied as the input electrical signal concerned to a lightwave signal (it is hereafter called FM laser), The 2nd source of a signal which outputs the 2nd non-correlated electrical signal to the 1st electrical signal, The external light modulation section which carries out the optical phase modulation of the output lightwave signal from FM laser with the 2nd electrical signal which has the property to change change of an input electrical signal into a meaning at change of an optical phase, and is supplied as the input electrical signal concerned, and is outputted, the 1st optical waveguide section which draws the output lightwave signal from the external light modulation section, and oscillation wavelength lambda 1 of FM laser Wavelength lambda 0 from which only **lambda differs the source of station luminescence which outputs light, the 2nd optical waveguide section which draws the output light from the source of station luminescence, and square -- with a detection property When two light of different wavelength is inputted, it has the property to generate the beat component of the two light concerned in the frequency equivalent to the wavelength difference. The output lightwave signal from the external light modulation section drawn by the 1st optical waveguide section and the output light from the source of station luminescence drawn by the 2nd optical waveguide section are inputted, and it has the optical detection section which outputs the beat component of the two light concerned in the frequency equivalent to those wavelength difference **lambda.
[0012] By modulating the inrush current of FM laser, an optical frequency modulating signal is generated and the broadband FM modulating signal generated by carrying out heterodyne detection of this generates high order distortion at the time of a recovery by the ripple of the group delay frequency characteristics of a transmission line, or FM recovery property. In the 1st above-mentioned invention, further the optical frequency modulating signal outputted from FM laser using the external light modulation section then, by performing the optical phase modulation [**** / modulating signal / optical frequency / from FM laser /-less] FM modulator which graduates the ripple of group delay frequency characteristics or FM recovery property on parenchyma, oppresses high order distortion which should be generated by these, and oppresses wave degradation by the property of a transmission line or FM demodulator circuit is realizable.
[0013] The 1st source of a signal which the 2nd invention is equipment made to generate a broadband FM modulating signal, and outputs the 1st electrical signal, It sets to the steady state from which an input electrical signal does not change, and is wavelength lambda 1. Light is oscillated. The laser for FM modulation which changes and outputs the 1st electrical signal which has the property to change amplitude change of an input electrical signal into a meaning at change of optical frequency, and is supplied as the input electrical signal concerned to a lightwave signal (it is hereafter called FM laser), The 1st optical waveguide section which draws the output lightwave signal from FM laser, and the 2nd source of a signal which outputs the 2nd non-correlated electrical signal to the 1st electrical signal, Oscillation wavelength lambda 1 of FM laser Wavelength lambda 0 from which only **lambda differs The source of station luminescence which outputs light, The external light modulation section which carries out the optical phase modulation of the output light from the source of station luminescence with the 2nd electrical signal which has the property to change change of an input electrical signal into a meaning at change of an optical phase, and is supplied as the input electrical signal concerned, and is outputted, the 2nd optical waveguide section which draws the output lightwave signal from the external light

modulation section, and square -- with a detection property When two light of different wavelength is inputted, it has the property to generate the beat component of the two light concerned in the frequency equivalent to the wavelength difference. The output lightwave signal from FM laser led by the 1st optical waveguide section and the output lightwave signal from the extraneous light phase modulation section drawn by the 2nd optical waveguide section are inputted, and it has the optical detection section which outputs the beat component of the two light concerned in the frequency equivalent to those wavelength difference **lambda.
[0014] In the 2nd above-mentioned invention, FM modulator which graduates the ripple of group delay frequency characteristics or FM recovery property on parenchyma, oppresses high order distortion which should be generated by these like the 1st invention, and oppresses wave degradation by the property of a transmission line or FM demodulator circuit is realizable by multiplexing the output lightwave signal from the extraneous light phase modulation section [**** / modulating signal / optical frequency / from FM laser /-less].
[0015] The 1st source of a signal which the 3rd invention is equipment made to generate a broadband FM modulating signal, and outputs the 1st electrical signal, It sets to the steady state from which an input electrical signal does not change, and is wavelength lambda 1. Light is oscillated. The laser for FM modulation which changes and outputs the 1st electrical signal which has the property to change amplitude change of an input electrical signal into a meaning at change of optical frequency, and is supplied as the input electrical signal concerned to a lightwave signal (it is hereafter called FM laser), The 1st optical waveguide section which draws the output lightwave signal from FM laser, and the 2nd source of a signal which outputs the 2nd non-correlated electrical signal to the 1st electrical signal, It sets to the steady state from which an input electrical signal does not change, and is the oscillation wavelength lambda 1 of FM laser. Wavelength lambda 0 from which only deltalambda differs Light is oscillated. The source of station luminescence which changes and outputs the 2nd electrical signal which has the property to change amplitude change of an input electrical signal into a meaning at change of optical frequency, and is supplied as the input electrical signal concerned to a lightwave signal, the 2nd optical waveguide section which draws the output lightwave signal from the source of station luminescence, and square -- with a detection property When two light of different wavelength is inputted, it has the property to generate the beat component of the two light concerned in the frequency equivalent to the wavelength difference. The output lightwave signal from FM laser led by the 1st optical waveguide section and the output lightwave signal from the source of station luminescence drawn by the 2nd optical waveguide section are inputted, and it has the optical detection section which outputs the beat component of the two light concerned in the frequency equivalent to those wavelength difference **lambda.
[0016] In the 3rd above-mentioned invention, FM modulator which graduates the ripple of group delay frequency characteristics or FM recovery property on parenchyma, oppresses high order distortion which should be generated by these like the 1st invention, and oppresses wave degradation by the property of a transmission line or FM demodulator circuit is realizable by multiplexing the output lightwave signal from the source [**** / modulating signal / optical frequency / from FM laser /-less] of office luminescence.
[0017] The 1st source of a signal which the 4th invention is equipment made to generate a broadband FM modulating signal, and outputs the 1st electrical signal, The 2nd source of a signal which outputs the 2nd non-correlated electrical signal to the 1st electrical signal, It sets to the multiplexing section which multiplexs and outputs the 1st electrical signal and 2nd electrical signal, and the steady state from which an input electrical signal does not change, and is wavelength lambda 1. Light is oscillated. The laser for FM modulation which changes and outputs the electrical signal which has the property to change amplitude change of an input electrical signal into a meaning at change of optical frequency, and is outputted from the multiplexing section to a lightwave signal (henceforth FM laser), the 1st optical waveguide section which draws the output lightwave signal from FM laser, and oscillation wavelength lambda 1 of FM laser Wavelength lambda 0 from which only **lambda differs the source of station luminescence which outputs light, the 2nd optical waveguide section which draws the output light from the source of station luminescence, and square -- with a detection property When two light of different wavelength is inputted, it has the property to generate the beat component of the two light concerned in the frequency equivalent to the wavelength difference. The output lightwave signal from FM laser led by the 1st optical waveguide section and the output light from the source of station luminescence drawn by the 2nd optical waveguide section are inputted, and it has the optical detection section which outputs the beat component of the two light concerned in the frequency equivalent to those wavelength difference **lambda.
[0018] By multiplexing the 2nd electrical signal [**** / electrical signal / 1st /-less] in the 4th above-mentioned invention, and performing an optical frequency modulation using optical frequency modulation

actuation of FM laser in addition to FM laser FM modulator which graduates the ripple of group delay frequency characteristics or FM recovery property on parenchyma, oppresses high order distortion which should be generated by these like the 1st invention, and oppresses wave degradation by the property of a transmission line or FM demodulator circuit is realizable.
[0019] 5th invention is characterized by the frequency of the 2nd electrical signal being high compared with the frequency of the 1st electrical signal in the 1st – one of invention of the 4th. In the 5th above-mentioned invention, it is set as a RF rather than the 1st electrical signal which should transmit the 2nd electrical signal essentially, and the substantial smoothing effectiveness of the ripple of the group delay frequency characteristics in the 1st – the 4th invention and FM recovery property is clarified more.
[0020] 6th invention is characterized by the frequency of the 2nd electrical signal being larger than the twice of the frequency of the 1st electrical signal in the 1st – one of invention of the 4th. In the 6th above-mentioned invention, the 1st electrical signal which should transmit the frequency of the 2nd electrical signal essentially is larger than twice, and it sets up, and avoids that the distorted component generated by the interaction of the 1st electrical signal and the 2nd electrical signal serves as an interference to the 1st electrical signal, and the substantial smoothing effectiveness of the ripple of the group delay frequency characteristics in the 1st – the 4th invention and FM recovery property is clarified more.
[0021]
[Embodiment of the Invention] FM modulator concerning the 1st operation gestalt of this invention is explained with reference to drawing 1 which shows the component and a connection mode. In drawing 1 , FM modulator is equipped with the 1st source 101 of a signal, the laser 102 for FM modulation (henceforth, FM laser), the 1st optical waveguide section 103, the source 104 of office luminescence, the 2nd optical waveguide section 105, the optical detection section 106, the 2nd source 107 of a signal, and the extraneous light phase modulation section 108 as the component.
[0022] Next, the connection mode of FM modulator and actuation which are shown in drawing 1 are explained. The 1st source 101 of a signal outputs the 1st electrical signal used as the dimension signal which should carry out FM modulation. Typically, it consists of semiconductor laser, it sets under the condition of inrush current regularity, and the FM laser 102 is wavelength lambda 1. When light is oscillated and amplitude modulation of the inrush current is carried out with the 1st electrical signal, oscillation wavelength (optical frequency) also receives a modulation and it is wavelength lambda 1. The optical frequency modulating signal made into the core is outputted. The 2nd source 107 of a signal outputs the 2nd electrical signal [**** / electrical signal / 1st /-less], and the extraneous light phase modulation section 108 performs an optical phase modulation with the 2nd electrical signal to the output lightwave signal from the FM laser 102. The 1st optical waveguide section 103 draws the lightwave signal outputted from this external light modulation section 108. The source 104 of station luminescence is the oscillation wavelength lambda 1 of the FM laser 102. Wavelength lambda 0 from which only specified quantity **lambda differs Light is outputted. The 2nd optical waveguide section 105 draws a light from the source 104 of station luminescence non-become irregular. It is multiplexed and two light drawn by the 1st optical waveguide section 103 and the 2nd optical waveguide section 105 is inputted into the optical detection section 106. the optical detection section 106 -- the square -- a detection property performs heterodyne detection and the beat signal of the two light concerned is outputted in the frequency equivalent to wavelength difference **lambda of the output lightwave signal from the extraneous light phase modulation section 108, and the output light from the source 104 of station luminescence. This beat signal is a broadband FM modulating signal which made the dimension signal the 1st electrical signal and 2nd electrical signal.
[0023] Drawing 2 is the block diagram showing the configuration of FM modulator concerning the 2nd operation gestalt of this invention. In drawing 2 , since FM modulator has the same component as the 1st operation gestalt, it attaches the same reference number about a corresponding component. However, since a connection mode is different with the 1st and 2nd operation gestalten, below actuation of FM modulator applied to the 2nd operation gestalt focusing on this point of difference is explained, and explanation of a point clear from the 1st operation gestalt is omitted. The 1st optical waveguide section 103 leads the lightwave signal outputted from the FM laser 102 to the optical detection section 106. The extraneous light phase modulation section 108 performs an optical phase modulation with the 2nd electrical signal to a light from the source 104 of station luminescence non-become irregular. The 2nd optical waveguide section 105 leads the lightwave signal outputted from this extraneous light phase modulation section 108 to the optical detection section 106. The optical detection section 106 outputs the beat signal of the two light concerned in the frequency equivalent to wavelength difference **lambda of the output lightwave signal from the FM laser 102, and the output lightwave signal from

the extraneous light phase modulation section 108.
[0024] Drawing 3 is the block diagram showing the configuration of FM modulator concerning the 3rd operation gestalt of this invention. In drawing 3 , since only the points which are not equipped with the extraneous light phase modulation section 108 as compared with the 2nd operation gestalt differ, FM modulator gives the same reference number to a corresponding configuration. Furthermore, since a connection mode is also different with the 2nd and 3rd operation gestalten, below actuation of FM modulator applied to the 3rd operation gestalt focusing on these points of difference is explained, and explanation of a point clear from the 2nd operation gestalt is omitted. Typically, it consists of semiconductor laser, it sets under the condition of inrush current regularity, and the source 104 of station luminescence is wavelength lambda 0. When light is oscillated and amplitude modulation of the inrush current is carried out with the 2nd electrical signal, oscillation wavelength (optical frequency) also receives a modulation and it is wavelength lambda 0. The optical frequency modulating signal made into the core is outputted. The 2nd optical waveguide section 105 draws the lightwave signal outputted from this source 104 of station luminescence. The optical detection section 106 outputs the beat signal of the two light concerned in the frequency equivalent to wavelength difference **lambda of the output lightwave signal from the FM laser 102, and the output light from the source 104 of station luminescence.
[0025] above-mentioned the 1- the 2nd electrical signal graduates the periodic fine ripple in group delay frequency characteristics and FM recovery property in a transmission line of FM modulating signal on parenchyma, and oppresses the waveform distortion at the time of the recovery of the broadband FM modulating signal by this in the 3rd operation gestalt, not affecting transmission of the 1st electrical signal, and the signal quality at the time of a recovery to the 1st electrical signal which should be transmitted essentially, since it is a signal [**** /-less]. Moreover, especially, since it has composition which supplies the 2nd electrical signal to the source 104 of station luminescence directly in the 3rd operation gestalt and the extraneous light phase modulation section 108 which was required of the 1st and 2nd operation gestalten is not needed, FM modulator can be constituted easily and the manufacturing cost can be reduced.
[0026] Drawing 4 is the block diagram showing the configuration of FM modulator concerning the 4th operation gestalt of this invention. In drawing 4 , since only the points which replace with the extraneous light phase modulation section 108 as compared with the 1st operation gestalt, and are equipped with the multiplexing section 109 differ, FM modulator gives the same reference number to a corresponding configuration. Furthermore, since a connection mode is also different with the 1st and 4th operation gestalten, below actuation of FM modulator applied to the 4th operation gestalt focusing on these points of difference is explained, and explanation of a point clear from the 1st operation gestalt is omitted. The multiplexing section 109 multiplexs the 1st electrical signal and 2nd electrical signal mutually, and inputs this into the FM laser 102. [**** /-less] The FM laser 102 carries out amplitude modulation of the inrush current with the electrical signal outputted from this multiplexing section 109, and is wavelength lambda 1. The optical frequency modulating signal made into the core is outputted. The 1st optical waveguide section 103 leads the lightwave signal outputted from the FM laser 102 to the optical detection section 106. The optical detection section 106 outputs the beat signal of the two light concerned in the frequency equivalent to wavelength difference **lambda of the output lightwave signal from the FM laser 102, and the output light from the source 104 of station luminescence.
[0027] here -- above-mentioned the 1- like the 3rd operation gestalt, to the 1st electrical signal which should be transmitted essentially, since the 2nd electrical signal is a signal [**** /-less], without affecting transmission of the 1st electrical signal, and the signal quality at the time of a recovery, it graduates the periodic fine ripple in the group delay frequency characteristics of a transmission line, or the f-V property of FM demodulator circuit on parenchyma, and oppresses the waveform distortion at the time of the recovery of the broadband FM modulating signal by this. However, with the 4th operation gestalt both, since the 1st electrical signal and 2nd electrical signal are mutually inputted into the FM laser 102, it is necessary to set up the input level to the FM laser 102 of both signals so that total of whenever [light modulation] may not exceed 100%. [**** /-less]
[0028] FM modulator concerning the 5th operation gestalt of this invention is explained. the component of this FM modulator -- the 1- since it is the same as that of either of the 4th operation gestalt, explanation of the connection mode and actuation is omitted. In this operation gestalt, it supposes no correlating the 2nd electrical signal with the 1st electrical signal, and it sets the frequency as a RF compared with the 1st electrical signal further. the substantial smooth effectiveness by the 2nd electrical signal over a periodic fine ripple [in / by this / the group delay frequency characteristics of a transmission line, or the recovery property of FM demodulator circuit] -- the 1- it improves rather than that of the 4th operation gestalt. Moreover, this smooth

effectiveness improves, so that the frequency of the 2nd electrical signal is high.
[0029] FM modulator concerning the 6th operation gestalt of this invention is explained. the component of this FM modulator -- the 1- since it is the same as that of either of the 4th operation gestalt, explanation of the connection mode and actuation is omitted. In this operation gestalt, it supposes no correlating the 2nd electrical signal with the 1st electrical signal, and it sets up the frequency compared with the 1st electrical signal more greatly than twice further. the substantial smooth effectiveness by the 2nd electrical signal over a periodic fine ripple [in / it prevents the secondary intermodulation distortion between the 1st and 2nd electrical signals occurring in the occupancy band of the 1st electrical signal by this when the occupancy band of the 1st electrical signal is large, and / the group delay frequency characteristics of a transmission line, or the recovery property of FM demodulator circuit] -- the 1- it improves rather than that of the 4th operation gestalt. Moreover, this smooth effectiveness improves, so that the frequency of the 2nd electrical signal is high.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] As mentioned above, when the broadband FM modulating signal generated with FM modulator using optical frequency modulation actuation and heterodyne detection of semiconductor laser is transmitted, While CNR is improvable with the amount of large frequency deviation, in order that FM modulating signal may cover a broadband dramatically Since the group delay frequency characteristics of a transmission line and the recovery property of an FM demodulator in the band were changed in the shape of [which has very many crests and troughs] a ripple, a higher order distortion occurred greatly and there was a trouble of degrading the quality of a transmission signal.
[0010] So, the object of this invention is offering FM modulator with which the broadband FM modulating signal generated using optical frequency modulation actuation and heterodyne detection of semiconductor laser graduates substantially the ripple of the group delay frequency characteristics of a transmission line and FM recovery property of being influenced, and can reduce high order distortion.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram showing the configuration of FM modulator concerning the 1st operation gestalt of this invention.
[Drawing 2] It is the block diagram showing the configuration of FM modulator concerning the 2nd operation gestalt of this invention.
[Drawing 3] It is the block diagram showing the configuration of FM modulator concerning the 3rd operation gestalt of this invention.
[Drawing 4] It is the block diagram showing the configuration of FM modulator concerning the 4th operation gestalt of this invention.
[Drawing 5] It is the block diagram showing the configuration of the conventional FM modulator.
[Drawing 6] It is drawing for explaining the configuration of the transmission system of the broadband FM modulating signal generated by FM modulator.
[Drawing 7] It is a mimetic diagram for explaining the group delay frequency characteristics of an optical transmission line.
[Drawing 8] It is drawing for explaining the ripple in FM recovery property (f-V property) of FM demodulator circuit.
[Description of Notations]
101 -- 1st source of a signal
102 -- Laser for FM modulation (FM laser)
103 -- The 1st optical waveguide section
104 -- Source of station luminescence
105 -- The 2nd optical waveguide section
106 -- Optical detection section
107 -- 2nd source of a signal
108 -- External light modulation section
109 -- Multiplexing section

[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) 公開特許公報（Ａ）　(11)特許出願公開番号

特開平11－68670

(43)公開日　平成11年(1999) 3月9日

(51)Int.Cl.⁶	識別記号	F I	
H04B 10/152		H04B 9/00	L
10/142			
10/04			
10/06			

審査請求　未請求　請求項の数6　ＯＬ　（全 9 頁）

(21)出願番号　特願平9－216191

(22)出願日　平成9年(1997) 8月11日

(71)出願人　000005821
松下電器産業株式会社
大阪府門真市大字門真1006番地

(71)出願人　000004226
日本電信電話株式会社
東京都新宿区西新宿三丁目19番2号

(72)発明者　布施　優
大阪府門真市大字門真1006番地　松下電器産業株式会社内

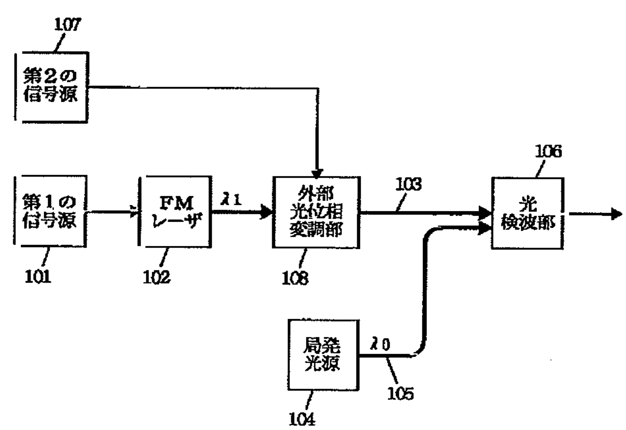
(72)発明者　内海　邦昭
大阪府門真市大字門真1006番地　松下電器産業株式会社内

(74)代理人　弁理士　小笠原　史朗

最終頁に続く

(54)【発明の名称】　ＦＭ変調装置

(57)【要約】
【課題】　広帯域ＦＭ変調信号が影響を受ける、伝送路の群遅延特性およびＦＭ復調特性のリップルを、実質的に平滑化し高次歪が低減できるＦＭ変調装置を提供することである。
【解決手段】　ＦＭレーザ１０２は、第１の信号源１０１から出力される第１の電気信号を、中心波長λ1 の光周波数変調信号に変換、出力する。第２の信号源１０７は、上記第１の電気信号に対して無相関な第２の伝送信号を出力し、外部光変調部１０８は、この第２の電気信号を用いて、ＦＭレーザからの出力光信号に光位相変調を施す。局発光源１０４は、ＦＭレーザ１０２の発振波長λ1 と所定量△λだけ異なる波長λ0 の光を出力する。外部光変調部１０８からの出力光信号および局発光源からの光は合波された後、光検波部１０６に入力されて、その自乗検波特性によりヘテロダイン検波を行い、入力される２つの光の波長差△λに相当する周波数において当該２つの光のビート信号を出力する。



【特許請求の範囲】

【請求項１】　広帯域ＦＭ変調信号を発生させる装置であって、
第１の電気信号を出力する第１の信号源と、
入力電気信号が変化しない定常状態において波長λ1 の光を発振し、入力電気信号の振幅変化を光周波数の変化に一意に変換する性質を有し、当該入力電気信号として供給される前記第１の電気信号を光信号に変換して出力するＦＭ変調用レーザ（以下、ＦＭレーザと呼ぶ）と、
前記第１の電気信号に無相関の第２の電気信号を出力する第２の信号源と、
入力電気信号の変化を光位相の変化に一意に変換する性質を有し、当該入力電気信号として供給される前記第２の電気信号により前記ＦＭレーザからの出力光信号を光位相変調して出力する外部光変調部と、
前記外部光変調部からの出力光信号を導く第１の光導波部と、
前記ＦＭレーザの発振波長λ1 と△λだけ異なる波長λ0 の光を出力する局発光源と、
前記局発光源からの出力光を導く第２の光導波部と、
自乗検波特性により、異なる波長の２つの光が入力された場合に、その波長差に相当する周波数に当該２つの光のビート成分を発生する性質を有し、前記第１の光導波部によって導かれた前記外部光変調部からの出力光信号と前記第２の光導波部によって導かれた前記局発光源からの出力光とを入力し、それらの波長差△λに相当する周波数において当該２つの光のビート成分を出力する光検波部とを備える、ＦＭ変調装置。

【請求項２】　広帯域ＦＭ変調信号を発生させる装置であって、
第１の電気信号を出力する第１の信号源と、
入力電気信号が変化しない定常状態において波長λ1 の光を発振し、入力電気信号の振幅変化を光周波数の変化に一意に変換する性質を有し、当該入力電気信号として供給される前記第１の電気信号を光信号に変換して出力するＦＭ変調用レーザ（以下、ＦＭレーザと呼ぶ）と、
前記ＦＭレーザからの出力光信号を導く第１の光導波部と、
前記第１の電気信号に無相関の第２の電気信号を出力する第２の信号源と、
前記ＦＭレーザの発振波長λ1 と△λだけ異なる波長λ0 の光を出力する局発光源と、
入力電気信号の変化を光位相の変化に一意に変換する性質を有し、当該入力電気信号として供給される前記第２の電気信号により前記局発光源からの出力光を光位相変調して出力する外部光変調部と、
前記外部光変調部からの出力光信号を導く第２の光導波部と、
自乗検波特性により、異なる波長の２つの光が入力された場合に、その波長差に相当する周波数に当該２つの光のビート成分を発生する性質を有し、前記第１の光導波部によって導かれた前記ＦＭレーザからの出力光信号と前記第２の光導波部によって導かれた前記外部光位相変調部からの出力光信号とを入力し、それらの波長差△λに相当する周波数において当該２つの光のビート成分を出力する光検波部とを備える、ＦＭ変調装置。

【請求項３】　広帯域ＦＭ変調信号を発生させる装置であって、
第１の電気信号を出力する第１の信号源と、
入力電気信号が変化しない定常状態において波長λ1 の光を発振し、入力電気信号の振幅変化を光周波数の変化に一意に変換する性質を有し、当該入力電気信号として供給される前記第１の電気信号を光信号に変換して出力するＦＭ変調用レーザ（以下、ＦＭレーザと呼ぶ）と、
前記ＦＭレーザからの出力光信号を導く第１の光導波部と、
前記第１の電気信号に無相関の第２の電気信号を出力する第２の信号源と、
入力電気信号が変化しない定常状態において前記ＦＭレーザの発振波長λ1 と△λだけ異なる波長λ0 の光を発振し、入力電気信号の振幅変化を光周波数の変化に一意に変換する性質を有し、当該入力電気信号として供給される前記第２の電気信号を光信号に変換して出力する局発光源と、
前記局発光源からの出力光信号を導く第２の光導波部と、
自乗検波特性により、異なる波長の２つの光が入力された場合に、その波長差に相当する周波数に当該２つの光のビート成分を発生する性質を有し、前記第１の光導波部によって導かれた前記ＦＭレーザからの出力光信号と前記第２の光導波部によって導かれた前記局発光源からの出力光信号とを入力し、それらの波長差△λに相当する周波数において当該２つの光のビート成分を出力する光検波部とを備える、ＦＭ変調装置。

【請求項４】　広帯域ＦＭ変調信号を発生させる装置であって、
第１の電気信号を出力する第１の信号源と、
前記第１の電気信号に無相関の第２の電気信号を出力する第２の信号源と、
前記第１の電気信号と前記第２の電気信号とを合波して出力する合波部と、
入力電気信号が変化しない定常状態において波長λ1 の光を発振し、入力電気信号の振幅変化を光周波数の変化に一意に変換する性質を有し、前記合波部から出力される電気信号を光信号に変換して出力するＦＭ変調用レーザ（以下、ＦＭレーザという）と、
前記ＦＭレーザからの出力光信号を導く第１の光導波部と、
前記ＦＭレーザの発振波長λ1 と△λだけ異なる波長λ0 の光を出力する局発光源と、

前記局発光源からの出力光を導く第２の光導波部と、自乗検波特性により、異なる波長の２つの光が入力された場合に、その波長差に相当する周波数に当該２つの光のビート成分を発生する性質を有し、前記第１の光導波部によって導かれた前記ＦＭレーザからの出力光信号と前記第２の光導波部によって導かれた前記局発光源からの出力光とを入力し、それらの波長差△λに相当する周波数において当該２つの光のビート成分を出力する光検波部とを備える、ＦＭ変調装置。

【請求項５】　前記第２の電気信号の周波数が、前記第１の電気信号の周波数に比べて高いことを特徴とする、請求項１～４のいずれかに記載のＦＭ変調装置。

【請求項６】　前記第２の電気信号の周波数が、前記第１の電気信号の周波数の２倍より大きいことを特徴とする、請求項１～４のいずれかに記載のＦＭ変調装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、ＦＭ変調装置に関し、より特定的には、半導体レーザを利用して、ＦＭ変調信号を発生するＦＭ変調装置に関する。

【０００２】

【従来の技術】図５は従来のＦＭ変調装置の構成を示したブロック図である。図５において、ＦＭ変調装置は、信号源５０１と、ＦＭ変調用レーザ（以下、ＦＭレーザという）５０２と、第１の光導波部５０３と、局発光源５０４と、第２の光導波部５０５と、光検波部５０６とを備えている。

【０００３】上記のように構成されたＦＭ変調装置において、信号源５０１はＦＭ変調すべき元信号となる電気信号を出力する。ＦＭレーザ５０２は、例えば半導体レーザで構成され、注入電流一定の条件では波長λ1 の光を発振し、注入電流を振幅変調すると、その発振波長（光周波数）も変調を受け、波長λ1 を中心とした光周波数変調信号を出力する。第１の光導波部５０３は、このＦＭレーザ５０２から出力された光信号を導く。局発光源５０４は、ＦＭレーザ５０２の発振波長λ1と所定量△λだけ異なる波長λ0 の光を出力する。第２の光導波部５０５は、局発光源５０４からの無変調光を導く。第１の光導波部５０３および第２の光導波部５０５によって導かれた２つの光は合波され、光検波部５０６に入力される。光検波部５０６は、自乗検波特性を有するフォトダイオードなどで構成され、異なる波長の２つの光が入力された場合には、その波長差に相当する周波数に２つの光のビート成分を発生する性質を備えており（この動作はヘテロダイン検波と呼ばれる）、第１の光導波部５０３によって導かれたＦＭレーザ５０２からの出力光信号と第２の光導波部５０５によって導かれた局発光源５０４からの出力光との波長差△λに相当する周波数において、これら２つの光のビート信号を出力する。

【０００４】以上のようにして得られたビート信号は、信号源５０１からの出力信号を元信号としたＦＭ変調信号であり、ＦＭレーザ５０２と局発光源５０４に適当なものを使用することによって、一般の電気回路によるＦＭ変調装置では実現困難な、数ＧＨｚ以上の中心周波数（搬送波周波数）と数１００ＭＨｚ以上の周波数偏移量とを有した非常に高周波かつ広帯域なＦＭ変調信号を容易に生成できる。この周波数偏移量の拡大により、このＦＭ変調信号を復調して得られるＦＭ復調信号は、高ＣＮＲ（搬送波対雑音電力比）を有することとなる。

【０００５】図６に、図５に示すＦＭ変調装置を含めた伝送装置の全体構成の一例を示す。文献（例えば、K.Kikushima, et al.,” Optical super wide-band FM modulation scheme and its application to multi-channel AM video transmission systems ”, IOOC’95 , PD2-7 , 1995.）にも記載されるように、この伝送装置は、図５のようなＦＭ変調装置６０１において生成された広帯域ＦＭ変調信号を、光送信部６０２が内部に含む伝送用レーザ６０３によって光強度変調信号に変換した後、光伝送路６０４を用いて当該光強度変調信号を伝送する。伝送装置は、光受信部６０５によって受信した光強度変調信号をＦＭ変調信号に再変換した後、ＦＭ復調回路６０７によって元の電気信号に復調する。ＦＭ復調回路６０７は遅延検波方式のＦＭ復調器で、識別部６０８は、光受信部６０５から入力されたＦＭ変調信号に対して所定の閾値Vref によって識別を行い、パルス信号（論理信号）に変換する。また、この識別部６０８は２つの出力ポートを有し、一方の出力信号は直接、他方の出力信号は遅延部６０９において所定の遅延量を与えられた後、乗算部６１０に入力される。乗算部６１０は、両パルス信号の論理積信号（パルス信号）を作成する。フィルタ６１１がこのパルス信号に対して低周波成分のみを通過させ出力すると、その出力信号の振幅変動成分は、入力ＦＭ変調信号の周波数変動成分に一意に対応しており、これによってＦＭ変調信号の復調を行う。識別部６０８および乗算部６１０には、高速信号処理用の論理素子（ＡＮＤゲートなど）を用いることにより、図５の構成で生成された高周波かつ広帯域なＦＭ変調信号を容易に復調することができる。

【０００６】ところで、一般に、ＦＭ変調信号の伝送装置においては、ＦＭ変調信号の帯域内における伝送路の群遅延特性が、伝送信号の品質に影響を与えることが知られている。例えば、図７（ａ）に示すように、群遅延量の周波数特性が帯域内において比較的緩やかに変化する場合については、２次、３次などの低次の歪成分が発生し、図７（ｂ）のように、群遅延量が帯域内で細かな山・谷を有するリップル状に変動する場合には、文献（例えば、石井他；”広帯域ＦＭ変調型光映像伝送システムにおける群遅延歪に関する理論検討”、信学技報ＯＣＳ９６－１７、１９９６．など）にも述べられているように４次以上の高次歪が発生し、伝送信号品質を劣化

させる。特に後者の高次歪については、歪補償技術などによる歪の低減手法の適用が難しく、群遅延の帯域内リップルは、あらかじめ充分に抑圧しておく必要がある。しかしながら、群遅延特性は、伝送路に使用する構成部品間または構成部品内のインピーダンスの不整合で生じる場合が殆どであり、皆無にすることは非常に難しい。

【０００７】次に、図６で説明したＦＭ復調回路６０７の入力周波数対出力信号レベル（ｆ－Ｖ特性）の一測定例を図８（ａ）に、ｆ－Ｖ特性を直線近似した場合の近似値と真値との差異（Δ出力電圧）を図８（ｂ）に示す。復調信号の波形歪の観点から、ＦＭ復調回路のｆ－Ｖ特性についても線形であることが望ましいが、図８（ｂ）から分かるように、細かなリップルを有しており、これもまた高次歪を発生させる要因となり、伝送信号の品質を劣化させる。

【０００８】以上のように、ＦＭ変調信号の伝送装置においては、伝送路の群遅延特性やＦＭ復調特性における非線形性が、伝送信号の品質に影響を与える。特に、図５～図８を用いて説明した広帯域ＦＭ変調信号の伝送装置においては、伝送信号の帯域が数ＧＨｚに亘るために、群遅延特性やＦＭ復調特性における帯域内のリップルの山・谷の数も非常に多くなり、より高次の歪が発生し、伝送信号の品質を大きく劣化させることになる。

【０００９】

【発明が解決しようとする課題】上述のように、半導体レーザの光周波数変調動作とヘテロダイン検波を利用したＦＭ変調装置により生成した広帯域ＦＭ変調信号を伝送する場合、大周波数偏移量によりＣＮＲを改善できる一方、ＦＭ変調信号が非常に広帯域に亘るために、その帯域内における伝送路の群遅延特性やＦＭ復調器の復調特性が非常に多くの山・谷を有するリップル状に変動するので、より高次の歪が大きく発生して、伝送信号の品質を劣化させるという問題点があった。

【００１０】それ故に、本発明の目的は、半導体レーザの光周波数変調動作とヘテロダイン検波を利用して生成した広帯域ＦＭ変調信号が影響を受ける、伝送路の群遅延特性およびＦＭ復調特性のリップルを、実質的に平滑化し高次歪が低減できるＦＭ変調装置を提供することである。

【００１１】

【課題を解決するための手段および発明の効果】第１の発明は、広帯域ＦＭ変調信号を発生させる装置であって、第１の電気信号を出力する第１の信号源と、入力電気信号が変化しない定常状態において波長λ1 の光を発振し、入力電気信号の振幅変化を光周波数の変化に一意に変換する性質を有し、当該入力電気信号として供給される第１の電気信号を光信号に変換して出力するＦＭ変調用レーザ（以下、ＦＭレーザと呼ぶ）と、第１の電気信号に無相関の第２の電気信号を出力する第２の信号源と、入力電気信号の変化を光位相の変化に一意に変換する性質を有し、当該入力電気信号として供給される第２の電気信号によりＦＭレーザからの出力光信号を光位相変調して出力する外部光変調部と、外部光変調部からの出力光信号を導く第１の光導波部と、ＦＭレーザの発振波長λ1 と△λだけ異なる波長λ0 の光を出力する局発光源と、局発光源からの出力光を導く第２の光導波部と、自乗検波特性により、異なる波長の２つの光が入力された場合に、その波長差に相当する周波数に当該２つの光のビート成分を発生する性質を有し、第１の光導波部によって導かれた外部光変調部からの出力光信号と第２の光導波部によって導かれた局発光源からの出力光とを入力し、それらの波長差△λに相当する周波数において当該２つの光のビート成分を出力する光検波部とを備える。

【００１２】ＦＭレーザの注入電流を変調することによって光周波数変調信号を発生し、これをヘテロダイン検波することによって生成された広帯域ＦＭ変調信号は、伝送路の群遅延特性やＦＭ復調特性のリップルによって、復調時において高次歪を発生する。そこで、上記第１の発明では、ＦＭレーザから出力された光周波数変調信号を、さらに外部光変調部を用いて、ＦＭレーザからの光周波数変調信号に無相関な光位相変調を施しておくことによって、群遅延特性やＦＭ復調特性のリップルを実質上平滑化して、これらによって発生するはずの高次歪を抑圧し、伝送路やＦＭ復調回路の特性による波形劣化を抑圧するＦＭ変調装置を実現することができる。

【００１３】第２の発明は、広帯域ＦＭ変調信号を発生させる装置であって、第１の電気信号を出力する第１の信号源と、入力電気信号が変化しない定常状態において波長λ1 の光を発振し、入力電気信号の振幅変化を光周波数の変化に一意に変換する性質を有し、当該入力電気信号として供給される第１の電気信号を光信号に変換して出力するＦＭ変調用レーザ（以下、ＦＭレーザと呼ぶ）と、ＦＭレーザからの出力光信号を導く第１の光導波部と、第１の電気信号に無相関の第２の電気信号を出力する第２の信号源と、ＦＭレーザの発振波長λ1 と△λだけ異なる波長λ0 の光を出力する局発光源と、入力電気信号の変化を光位相の変化に一意に変換する性質を有し、当該入力電気信号として供給される第２の電気信号により局発光源からの出力光を光位相変調して出力する外部光変調部と、外部光変調部からの出力光信号を導く第２の光導波部と、自乗検波特性により、異なる波長の２つの光が入力された場合に、その波長差に相当する周波数に当該２つの光のビート成分を発生する性質を有し、第１の光導波部によって導かれたＦＭレーザからの出力光信号と第２の光導波部によって導かれた外部光位相変調部からの出力光信号とを入力し、それらの波長差△λに相当する周波数において当該２つの光のビート成分を出力する光検波部とを備える。

【００１４】上記第２の発明では、ＦＭレーザからの光

周波数変調信号に無相関な外部光位相変調部からの出力光信号を合波することによって、第1の発明と同様に、群遅延特性やFM復調特性のリップルを実質上平滑化して、これらによって発生するはずの高次歪を抑圧し、伝送路やFM復調回路の特性による波形劣化を抑圧するFM変調装置を実現することができる。

【0015】第3の発明は、広帯域FM変調信号を発生させる装置であって、第1の電気信号を出力する第1の信号源と、入力電気信号が変化しない定常状態において波長λ1 の光を発振し、入力電気信号の振幅変化を光周波数の変化に一意に変換する性質を有し、当該入力電気信号として供給される第1の電気信号を光信号に変換して出力するFM変調用レーザ（以下、FMレーザと呼ぶ）と、FMレーザからの出力光信号を導く第1の光導波部と、第1の電気信号に無相関の第2の電気信号を出力する第2の信号源と、入力電気信号が変化しない定常状態においてFMレーザの発振波長λ1 とΔλだけ異なる波長λ0 の光を発振し、入力電気信号の振幅変化を光周波数の変化に一意に変換する性質を有し、当該入力電気信号として供給される第2の電気信号を光信号に変換して出力する局発光源と、局発光源からの出力光信号を導く第2の光導波部と、自乗検波特性により、異なる波長の2つの光が入力された場合に、その波長差に相当する周波数に当該2つの光のビート成分を発生する性質を有し、第1の光導波部によって導かれたFMレーザからの出力光信号と第2の光導波部によって導かれた局発光源からの出力光信号とを入力し、それらの波長差Δλに相当する周波数において当該2つの光のビート成分を出力する光検波部とを備える。

【0016】上記第3の発明では、FMレーザからの光周波数変調信号に無相関な局発光源からの出力光信号を合波することによって、第1の発明と同様に、群遅延特性やFM復調特性のリップルを実質上平滑化して、これらによって発生するはずの高次歪を抑圧し、伝送路やFM復調回路の特性による波形劣化を抑圧するFM変調装置を実現することができる。

【0017】第4の発明は、広帯域FM変調信号を発生させる装置であって、第1の電気信号を出力する第1の信号源と、第1の電気信号に無相関の第2の電気信号を出力する第2の信号源と、第1の電気信号と第2の電気信号とを合波して出力する合波部と、入力電気信号が変化しない定常状態において波長λ1 の光を発振し、入力電気信号の振幅変化を光周波数の変化に一意に変換する性質を有し、合波部から出力される電気信号を光信号に変換して出力するFM変調用レーザ（以下、FMレーザという）と、FMレーザからの出力光信号を導く第1の光導波部と、FMレーザの発振波長λ1 とΔλだけ異なる波長λ0 の光を出力する局発光源と、局発光源からの出力光を導く第2の光導波部と、自乗検波特性により、異なる波長の2つの光が入力された場合に、その波長差に相当する周波数に当該2つの光のビート成分を発生する性質を有し、第1の光導波部によって導かれたFMレーザからの出力光信号と第2の光導波部によって導かれた局発光源からの出力光とを入力し、それらの波長差Δλに相当する周波数において当該2つの光のビート成分を出力する光検波部とを備える。

【0018】上記第4の発明では、第1の電気信号に無相関な第2の電気信号とを合波してFMレーザに加え、FMレーザの光周波数変調動作を利用して、光周波数変調を施すことによって、第1の発明と同様に、群遅延特性やFM復調特性のリップルを実質上平滑化して、これらによって発生するはずの高次歪を抑圧し、伝送路やFM復調回路の特性による波形劣化を抑圧するFM変調装置を実現することができる。

【0019】第5の発明は、第1～第4のいずれかの発明において、第2の電気信号の周波数が、第1の電気信号の周波数に比べて高いことを特徴とする。上記第5の発明では、第2の電気信号を本来伝送すべき第1の電気信号よりも高周波に設定し、第1～第4の発明における群遅延特性およびFM復調特性のリップルの実質的な平滑化効果をより明確にする。

【0020】第6の発明は、第1～第4のいずれかの発明において、第2の電気信号の周波数が、第1の電気信号の周波数の2倍より大きいことを特徴とする。上記第6の発明では、第2の電気信号の周波数を本来伝送すべき第1の電気信号の2倍よりも大きく設定し、第1の電気信号と第2の電気信号の相互作用によって発生する歪成分が第1の電気信号に対する妨害波となることを避け、かつ第1～第4の発明における群遅延特性およびFM復調特性のリップルの実質的な平滑化効果をより明確にする。

【0021】

【発明の実施の形態】本発明の第1の実施形態に係るFM変調装置について、その構成要素および接続態様を示す図1を参照して、説明する。図1において、FM変調装置は、その構成要素として、第1の信号源101と、FM変調用レーザ（以下、FMレーザ）102と、第1の光導波部103と、局発光源104と、第2の光導波部105と、光検波部106と、第2の信号源107と、外部光位相変調部108とを備えている。

【0022】次に、図1に示すFM変調装置の接続態様と動作を説明する。第1の信号源101はFM変調すべき元信号となる第1の電気信号を出力する。FMレーザ102は、代表的には半導体レーザで構成され、注入電流一定の条件下においては波長λ1 の光を発振し、第1の電気信号により注入電流を振幅変調すると、発振波長（光周波数）も変調を受け、波長λ1 を中心とした光周波数変調信号を出力する。第2の信号源107は、第1の電気信号に無相関な第2の電気信号を出力し、外部光位相変調部108は、FMレーザ102からの出力光信

号に対して、第２の電気信号により光位相変調を行う。第１の光導波部１０３は、この外部光変調部１０８から出力された光信号を導く。局発光源１０４は、ＦＭレーザ１０２の発振波長λ1 と所定量△λだけ異なる波長λ0 の光を出力する。第２の光導波部１０５は、局発光源１０４からの無変調光を導く。第１の光導波部１０３および第２の光導波部１０５によって導かれた２つの光は合波され、光検波部１０６に入力される。光検波部１０６は、その自乗検波特性によりヘテロダイン検波を行い、外部光位相変調部１０８からの出力光信号と局発光源１０４からの出力光との波長差△λに相当する周波数において、当該２つの光のビート信号を出力する。このビート信号は、第１の電気信号および第２の電気信号を元信号とした広帯域ＦＭ変調信号である。

【００２３】図2は、本発明の第２の実施形態に係るＦＭ変調装置の構成を示すブロック図である。図2において、ＦＭ変調装置は、第１の実施形態と同様の構成要素を有するので、相当する構成要素については、同一の参照番号を付す。しかし、第１および第２の実施形態では接続態様が相違するので、以下にはこの相違点を中心に第２の実施形態に係るＦＭ変調装置の動作を説明し、第１の実施形態から明らかな点の説明は省略する。第１の光導波部１０３は、ＦＭレーザ１０２から出力された光信号を光検波部１０６に導く。外部光位相変調部１０８は、局発光源１０４からの無変調光に対して、第２の電気信号により光位相変調を行う。第２の光導波部１０５は、この外部光位相変調部１０８から出力された光信号を光検波部１０６に導く。光検波部１０６は、ＦＭレーザ１０２からの出力光信号と外部光位相変調部１０８からの出力光信号との波長差△λに相当する周波数において、当該２つの光のビート信号を出力する。

【００２４】図3は、本発明の第３の実施形態に係るＦＭ変調装置の構成を示すブロック図である。図3において、ＦＭ変調装置は、第２の実施形態と比較すると、外部光位相変調部１０８を備えない点のみが異なるので、相当する構成には同一の参照番号を付す。さらに、第２および第３の実施形態では接続態様も相違するので、以下には、これら相違点を中心に第３の実施形態に係るＦＭ変調装置の動作を説明し、第２の実施形態から明らかな点の説明は省略する。局発光源１０４は、代表的には半導体レーザで構成され、注入電流一定の条件下においては波長λ0 の光を発振し、第２の電気信号により注入電流を振幅変調すると、発振波長（光周波数）も変調を受け、波長λ0 を中心とした光周波数変調信号を出力する。第２の光導波部１０５は、この局発光源１０４から出力された光信号を導く。光検波部１０６は、ＦＭレーザ１０２からの出力光信号と局発光源１０４からの出力光との波長差△λに相当する周波数において、当該２つの光のビート信号を出力する。

【００２５】上述の第１～第３の実施形態において、第２の電気信号は、本来伝送すべき第１の電気信号に対して無相関な信号であるので、第１の電気信号の伝送および復調時の信号品質に影響を与えないものとしながら、ＦＭ変調信号の伝送路での群遅延特性やＦＭ復調特性における周期的な細かいリップルを実質上平滑化して、これによる広帯域ＦＭ変調信号の復調時の波形歪を抑圧する。また、特に第３の実施形態においては、第２の電気信号を直接的に局発光源１０４に供給する構成になっているため、第１及び第２の実施形態では必要であった外部光位相変調部１０８を必要としないので、ＦＭ変調装置を簡単に構成でき、その製造コストを低減できる。

【００２６】図4は、本発明の第４の実施形態に係るＦＭ変調装置の構成を示すブロック図である。図4において、ＦＭ変調装置は、第１の実施形態と比較すると、外部光位相変調部１０８に代えて合波部１０９を備える点のみが異なるので、相当する構成には同一の参照番号を付す。さらに、第１および第４の実施形態では接続態様も相違するので、以下には、これら相違点を中心に第４の実施形態に係るＦＭ変調装置の動作を説明し、第１の実施形態から明らかな点の説明は省略する。合波部１０９は、互いに無相関な第１の電気信号と第２の電気信号を合波して、これをＦＭレーザ１０２に入力する。ＦＭレーザ１０２は、この合波部１０９から出力された電気信号により注入電流を振幅変調し、波長λ1 を中心とした光周波数変調信号を出力する。第１の光導波部１０３は、ＦＭレーザ１０２から出力された光信号を光検波部１０６に導く。光検波部１０６は、ＦＭレーザ１０２からの出力光信号と局発光源１０４からの出力光との波長差△λに相当する周波数において、当該２つの光のビート信号を出力する。

【００２７】ここで、上記第１～第３の実施形態と同様に、第２の電気信号は、本来伝送すべき第１の電気信号に対して無相関な信号であるので、第１の電気信号の伝送および復調時の信号品質に影響を与えずに、伝送路の群遅延特性やＦＭ復調回路のｆ－Ｖ特性における周期的な細かいリップルを実質上平滑化して、これによる広帯域ＦＭ変調信号の復調時の波形歪を抑圧する。但し、第４の実施形態では、互いに無相関な第１の電気信号と第２の電気信号が共にＦＭレーザ１０２に入力されるため、その光変調度の総和が１００％を越えないよう、両信号のＦＭレーザ１０２への入力レベルを設定する必要がある。

【００２８】本発明の第５の実施形態に係るＦＭ変調装置について説明する。本ＦＭ変調装置の構成要素は、第１～第４の実施形態のいずれかと同様であるので、その接続態様および動作の説明を省略する。本実施形態において、第２の電気信号は、第１の電気信号と無相関とし、さらにその周波数を第１の電気信号に比べて、高周波に設定する。これによって、伝送路の群遅延特性やＦＭ復調回路の復調特性における周期的な細かいリップル

に対する第２の電気信号による実質的な平滑効果は、第１～第４の実施形態のそれよりも向上する。また、この平滑効果は、第２の電気信号の周波数が高い程向上する。

【００２９】本発明の第６の実施形態に係るＦＭ変調装置について説明する。本ＦＭ変調装置の構成要素は、第１～第４の実施形態のいずれかと同様であるので、その接続態様および動作の説明を省略する。本実施形態において、第２の電気信号は、第１の電気信号と無相関とし、さらにその周波数を第１の電気信号に比べて、２倍よりも大きく設定する。これによって、第１の電気信号の占有帯域が広い場合においても、第１および第２の電気信号間の２次相互変調歪が、第１の電気信号の占有帯域内に発生することを防ぎ、かつ伝送路の群遅延特性やＦＭ復調回路の復調特性における周期的な細かいリップルに対する第２の電気信号による実質的な平滑効果が、第１～第４の実施形態のそれよりも向上する。また、この平滑効果は、第２の電気信号の周波数が高い程向上する。

【図面の簡単な説明】

【図１】本発明の第１の実施形態に係るＦＭ変調装置の構成を示すブロック図である。

【図２】本発明の第２の実施形態に係るＦＭ変調装置の構成を示すブロック図である。

【図３】本発明の第３の実施形態に係るＦＭ変調装置の構成を示すブロック図である。

【図４】本発明の第４の実施形態に係るＦＭ変調装置の構成を示すブロック図である。

【図５】従来のＦＭ変調装置の構成を示すブロック図である。

【図６】ＦＭ変調装置によって生成される広帯域ＦＭ変調信号の伝送システムの構成を説明するための図である。

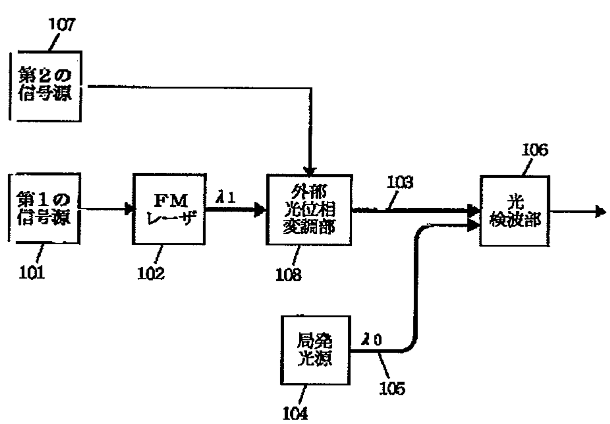
【図７】光伝送路の群遅延特性を説明するための模式図である。

【図８】ＦＭ復調回路のＦＭ復調特性（ｆ－Ｖ特性）におけるリップルを説明するための図である。

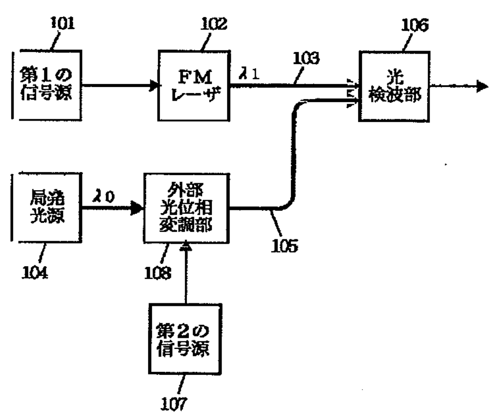
【符号の説明】

１０１…第１の信号源
１０２…ＦＭ変調用レーザ（ＦＭレーザ）
１０３…第１の光導波部
１０４…局発光源
１０５…第２の光導波部
１０６…光検波部
１０７…第２の信号源
１０８…外部光変調部
１０９…合波部

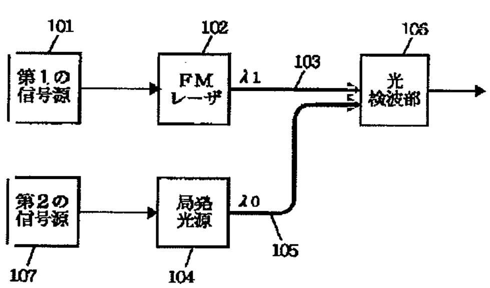
【図１】



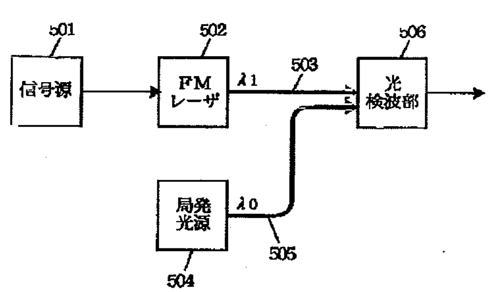
【図２】



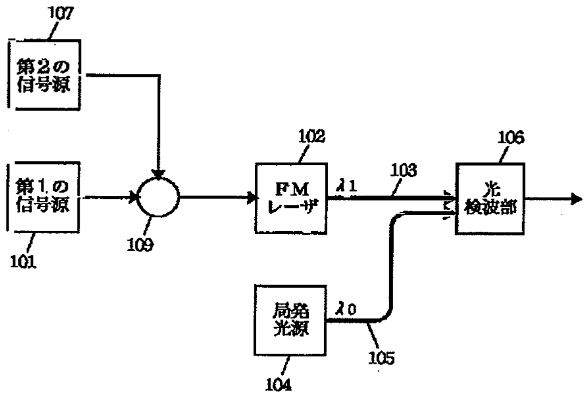
【図３】



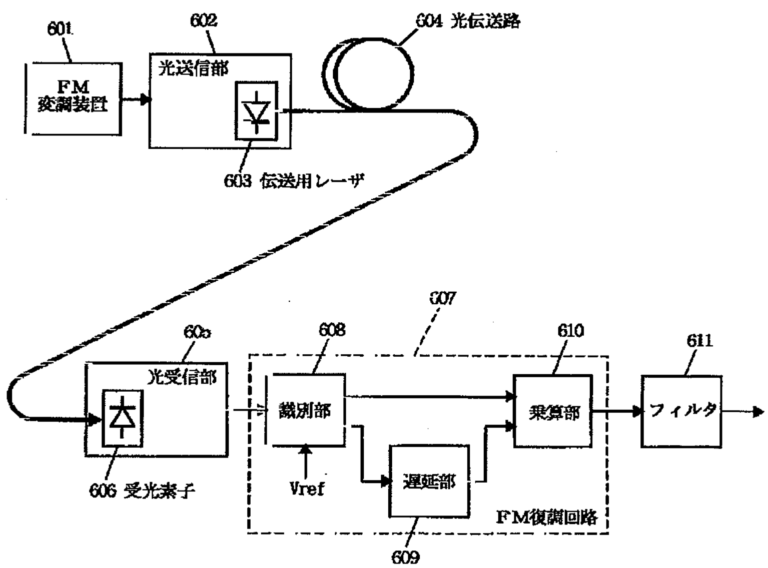
【図５】



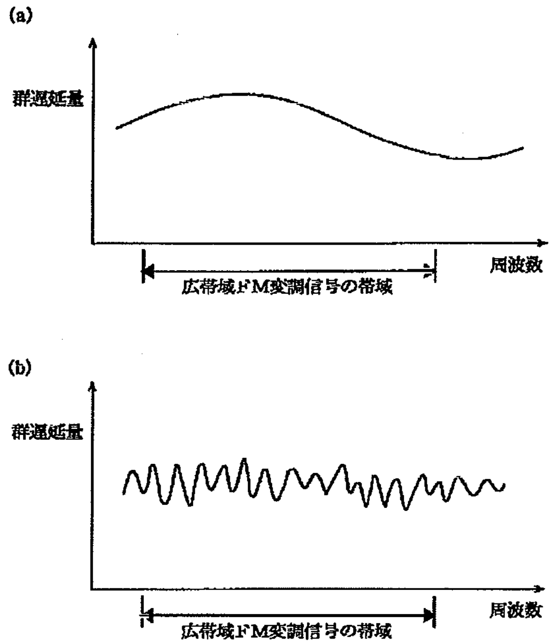
【図4】


107
第2の
信号源
第1の
信号源
101
109
102
FM
レーザ
λ1
103
106
光
検波部
局発
光源
λ0
104
105

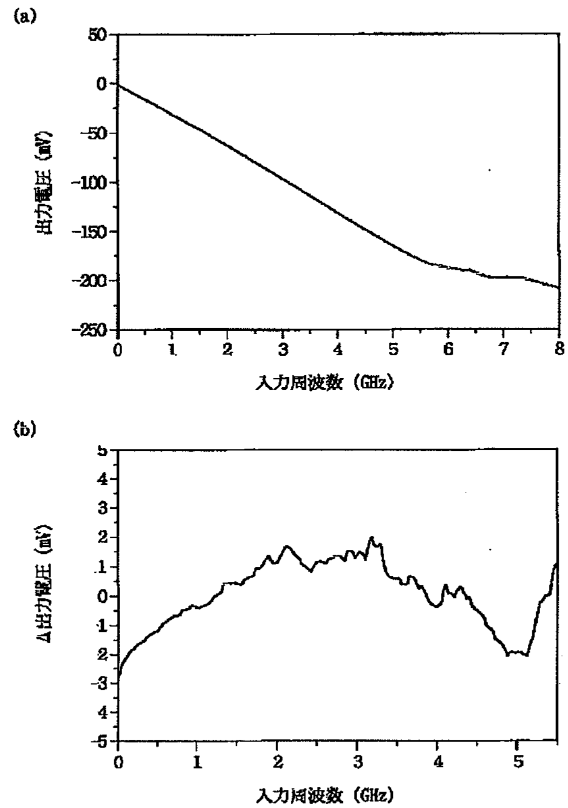
【図6】


601
FM
変調装置
602
光送信部
603 伝送用レーザ
604 光伝送路
605
光受信部
606 受光素子
607
608
識別部
Vref
609
遅延部
610
乗算部
FM復調回路
611
フィルタ

【図7】



【図8】



フロントページの続き

(72)発明者　川島　勢一郎
大阪府門真市大字門真1006番地　松下電器産業株式会社内

(72)発明者　菊島　浩二
東京都新宿区西新宿三丁目19番２号　日本電信電話株式会社内